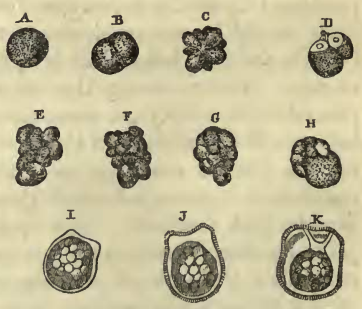
III.—*Remarks on MM. Koren and Danielssen's Researches on the Development of* Purpura lapillus. By Wm. B. Carpenter, M.D., F.R.S., F.G.S., F.L.S.

Although I have for some time had in my possession the Second Part of the 'Fauna littoralis Norvegiæ,' containing the second memoir of MM. Koren and Danielssen on the development of *Purpura lapillus*, yet it was not my intention to take any notice of their criticisms upon my observations, until I should have had the opportunity of again working through the subject. As the views of those gentlemen, however, have recently been brought prominently before the readers of the 'Annals' (see vol. xix. p. 433), and as my own have not been presented in its pages, I take the liberty of drawing attention to the following concise summary of them; referring such as desire a more detailed statement to the original memoir in the 'Transactions of the Microscopical Society,' new series, vol. iii.

It will be remembered that, according to MM. Koren and Danielssen, all the 500 or 600 egg-like bodies contained in any one capsule are of similar character: all undergoing coalescence into a conglomerate mass; and this mass subdividing itself into ovoidal bodies of larger or smaller size, each of which becomes converted into an embryo.

My view of the case is very different. Of these 500 or 600 egg-like bodies, I regard a small number only—usually from 12 to 30—as true *ova*, the remainder being only *yolk-spherules*, which are destined to serve for the nutrition of the embryos. The distinction between them manifests itself at a very early period, even in the first segmentation; for while the yolk-spherules divide into two equal hemispheres (fig. 1, B), the real ova divide into a larger and a smaller segment (D); in the cleft between these are seen the minute 'directive vesicles,' which appear to be always double or even triple, although, from being seen 'end-on,' only one may be visible; and near these is generally to be seen a clear space in each segment. The difference is still more strongly marked in the subsequent divisions; for whilst the cleavage of the yolk-spherules goes on irregularly, so as to divide each

Fig. 1.



Early stages of embryonic development of *Purpura lapillus*: A, egg-like spherule; B, C, E, F, G, successive stages of segmentation of yolk-spherules; D, H, I, J, K, successive stages of development of early embryos.

into from 14 to 20 segments having no definiteness of arrangement (c, e, f, g), that of the ova takes place in such a manner as to mark out the distinction, first noticed by Vogt (in his memoir on the development of *Actæon*), between the cephalic and the visceral portions of the mass (h); and the evolution of the former into distinct organs very speedily commences. In the first instance, a narrow transparent border is seen around the whole embryonic mass, which is broader at the cephalic portion (i); next, this border is fringed with short cilia, and the cephalic extension into two lobes begins to show itself; and then between the lobes a large mouth is formed, opening through a short, wide œsophagus, the interior of which is ciliated, into the visceral cavity, occupied as yet only by the yolk-segments originally belonging to the ovum (k).—Whilst these developmental changes are taking place in the embryo, the whole aggregate of segments formed by the subdivision of the yolk-spherules coalesces into one mass, as shown at a, fig. 2; and the embryos are often, in the first instance,

Fig. 2.

Later stages of embryonic development of *Purpura lapillus*: a, conglomerate mass of vitelline segments, to which were attached the embryos, *a*, *b*, *c*, *d*, *e*; b, full-sized embryo, in more advanced stage of development.

so completely buried within this, as only to be discoverable by tearing its portions asunder; but some of them may generally be found upon its exterior; and those contained in one capsule very commonly exhibit the different stages of development represented in fig. 1, h—k. After a short time, however, it becomes apparent that the most advanced embryos are beginning to *swallow* the yolk-segments of the conglomerate mass; and capsules will not unfrequently be met with, in which embryos of various sizes, as *a*, *b*, *c*, *d*, *e* (fig. 2, a), are projecting from its surface, their dif-

ference of size not being accompanied by advance in development, but merely depending upon the amount of this 'supplemental' yolk which the individuals have respectively gulped down. For during the time in which they are engaged in appropriating this additional supply of nutriment, although they increase in size, yet they scarcely exhibit any other change; so that the large embryo, fig. 2 *e*, is not apparently more advanced as regards the formation of its organs, than the small embryo, fig. 1, K. So soon as this operation has been completed, however, and the embryo has attained its full bulk, the evolution of its organs takes place very rapidly; the ciliated lobes are much more highly developed, being extended in a long sinuous margin, so as almost to remind the observer of the 'wheels' of Rotifera, and furnished with very long cilia (fig. 2, B); the auditory vesicles, the tentacula, the eyes, and the foot, successively make their appearance; a curious rhythmically-contractile vesicle is seen just beneath the edge of the shell in the region of the neck; a little later, the heart may be seen pulsating beneath the dorsal part of the shell; and the mass of yolk-segments of which the body is made up gradually shapes itself into the various organs of digestion, respiration, &c., during the evolution of which (and while they are as yet far from complete) the capsule thins away at its summit, and the embryos make their escape from it. It happens not unfrequently that one of the embryos which a capsule contains, does not acquire its supplemental yolk in the manner now described, and can only proceed in its development as far as its original yolk will afford it material; and thus, at the time when the other embryos have attained their full size and maturity, a strange-looking creature, consisting of two large ciliated lobes with scarcely the rudiment of a body, may be seen in active motion among them. This may happen, indeed, not only to one but to several embryos within the same capsule, especially if their number should be considerable; for it sometimes appears as if there were not food enough for all, so that whilst some attain their full dimensions and complete development, others remain of unusually small size, without being deficient in any of their organs, and others again are more or less completely abortive,—the supply of supplemental yolk which they have obtained having been too small for the development of their viscera, although it may have afforded what was needed for that of the ciliated lobes, eyes, tentacles, auditory vesicles, and even the foot,—or, on the other hand, no additional supply whatever having been acquired by them, so that their development has been arrested at a still earlier stage.

Now, in defence of the foregoing explanation of the process, and in reply to the criticisms of MM. Koren and Danielssen, I

beg to make the following remarks; premising that I speak not only for myself, but for Mr. G. Busk, whose independent observations (made for the purpose of testing the value of mine) led him to the complete adoption of the same view of the case.

1. The absence of any definite membranous envelope around the egg-like bodies, was, both to Mr. Busk and myself, a matter of certainty.

2. The existence, in certain of these bodies, of the 'directive vesicles,' which MM. Koren and Danielssen now concur with me in affirming, was most pointedly denied by them in their former memoir. They bring no new observations to invalidate my statement, that in the cases in which these bodies present themselves, the segmentation follows a regular plan, tending to the production of an embryo according to the ordinary Gasteropod type; but content themselves with affirming that the distinction which I have drawn between the segmentation of the true ova and that of the vitelline spheres is nugatory.

3. Although MM. Koren and Danielssen spoke in their first memoir of having only *occasionally* met with *one* of the embryos developed from a single ovum, they now admit that *several* such embryos are *usually* to be found in the capsule before the act of conglomeration has commenced; thus again confirming my statement as to a fact of fundamental importance. They do not offer any explanation of the ordinary presence of these small embryos, which is altogether meaningless, if (as affirmed by them) they speedily perish, but which is fully explained (on my view of the case) by their subsequent expansion into large embryos through the ingestion of the supplemental yolk. I have nowhere said, as is imputed to me, that all the bodies enclosed in the capsules are "anatomically and physiologically alike;" on the contrary, I contend that although there is originally no perceptible structural difference between the true ova and the vitelline spheres, a definite physiological difference manifests itself from the very commencement of the process of segmentation.

4. MM. Koren and Danielssen impute to me that I have (under the influence, as they assume, of a preconceived hypothesis) affirmed the existence of a mouth and a ciliated œsophagus in the small embryos, and have given delineations of these organs, without any other foundation than my own imagination, having mistaken for the œsophagus the foot in an incipient stage of development. It is not a little strange that if *I* have been deceived in this matter, so accurate and cautious an observer as Mr. Busk should have not only followed me in this error, but should have actually made the very drawings whose truthfulness is challenged. That my eyes should have deceived

me, when I saw, during the prolonged observation of the same individuals, yolk-segments actually pass down this œsophagus, and their bodies augment in bulk, does not strike me as very probable.

5. It is not a little significant that, putting aside the foregoing difference, the figures given by MM. Koren and Danielssen to illustrate their *second* memoir bear far more resemblance to mine, than they do to those by which their *first* memoir was illustrated. This fact, of which any one who compares the three sets of figures may readily satisfy himself, cannot but throw some doubt over the trustworthiness of the figures and descriptions originally given by those authors.

6. The contractile vesicle which was described and figured by MM. Koren and Danielssen in their first memoir as the heart, and which is distinguished by its projection from beneath the mantle during the middle period of development, I again affirm (and this without the slightest hesitation) *not* to be the heart. With the aid of the achromatic condenser, I was able to recognize what the presence of a distinct auricle and ventricle showed to be unmistakeably the heart, much deeper in the cavity of the mantle; and that these observers should *not* have recognized it, may be due to their not having transmitted a sufficiently strong light through the semi-opake body of the embryo. Although the reference they make in their second memoir to some other contractile vesicle (kidney ?) would seem to imply that they had recognized (as I have done) two distinct contractile organs, they have given no evidence of having done so.

I will not take upon myself to affirm that I have made no errors in my description of the process. Those who may take the trouble to consult my original memoir, will find that there are certain parts which I do not consider myself to have fully made out. But I cannot at present entertain any doubt as to the general facts of the case; and I submit that the admissions now made by MM. Koren and Danielssen go to strengthen my view of it. It is obvious that the main point to be decided by further observation is, whether I am right in affirming that in embryos developed from single ova, a ciliated mouth and œsophagus exist, down which yolk-spherules can pass; or whether, as MM. Koren and Danielssen assert, I have mistaken for the œsophagus the incipient foot. I would suggest to any observers who, during the present season, may have the opportunity of studying the development of *Purpura* (at Tenby the egg-capsules are so abundant that they may be gathered by the handful), that they give their special attention to this point, and that they endeavour so to place the embryos under the microscope, as to be able to look at the mouth from the front, as well as from the

side, and thus to see down into the short wide œsophagus. Such a view was obtained both by Mr. Busk and myself, and is represented in fig. 9 *b* of my memoir; but MM. Koren and Danielssen seem only to have examined these parts from the side.—I shall of course take the first opportunity of again applying myself to the investigation; and if I find that I have been in error, I shall lose no time in making public my retractation.

P.S. Since writing the above, I have been informed by Dr. Dyster of Tenby, that he has repeatedly verified the most important parts of my observations; viz. the development of embryos, possessing a mouth and ciliated œsophagus, from single ova, which are distinguished as such from the very commencement, by the mode of segmentation and the presence of the directive vesicles.

IV.—*On the Ultimate Structure of* Spongilla, *and Additional Notes on Freshwater Infusoria.* By H. J. Carter, Esq., Assistant Surgeon H. C. S., Bombay.

[With a Plate.]

In the "Postscript" to my notes on the organization of Infusoria, dated 10th June last*, it is stated that apertures exist in the investing membrane of *Spongilla*, and that the particles of carmine taken in through them pass into the substance of the sponge-cells. This was added chiefly to correct an assertion made in the body of the paper, that *Spongilla* lived by endosmosis. I also stated that I should recur to these facts more particularly hereafter; but since then, up to within the last month, I have not had an opportunity of again pursuing the subject. I have, however, during this time, succeeded in ascertaining the ultimate structure of *Spongilla*, by following its development from the seed-like body, and this I will now relate.

Those who are acquainted with *Spongilla* are aware, that it is charged towards the base with a number of seed-like bodies of a globular shape, each of which consists of a coriaceous membrane enclosing a number of delicate, transparent, spherical cells, more or less filled with ovules and granular matter, while an incrustation of gelatinous matter, charged with small spicules peculiar to the species, surrounds the exterior of the coriaceous membrane. It has also been shown that at an early period

* Annals, vol. xviii. p. 242.